Higgs WG Analysis Preparation

K. A. Assamagan, S. Horvat, M. Kado,

B. Mellado, W. Murray, A. Nisati

C. Potter, M. Schumacher, J. Tanaka

For the Higgs Working Group

The full 2009/10 sample (200 pb^{-1})

- **Spring 2010, few pb^{-1}: mainly calibrations and understanding of the detector performance. Collaborations with Trigger and CP Groups will be important**
- **Summer 2010, a few tens of pb^{-1}: Expect improved detector and trigger performance**
- **Full sample ~ 200/pb: Expect improved detector performance**
  - Maintain connection with performance groups
  - Involvement in calibration, data quality and luminosity estimation
  - First Higgs Papers on 2009/2010 data
- **Tight connection with SM and top groups**
  - JOINT meetings with SM subgroups: e.g., HSG1 ($H\rightarrow\gamma\gamma$)/Direct Photon, HSG2 ($H\rightarrow ZZ$) and HSG3 ($H\rightarrow WW$)/SM electroweak and dibosons, etc
  - Common analysis strategies
  - Background cross-section measurements
  - Simple cut-based analyses. Define signal-like regions and primary control samples
  - Little reliance on MC. Control sample definitions for data-driven background estimation
  - Signal selection efficiencies and impact of systematic uncertainties. Systematic error propagation
  - Sensitivity and N x σ(SM) exclusion at 95% CL

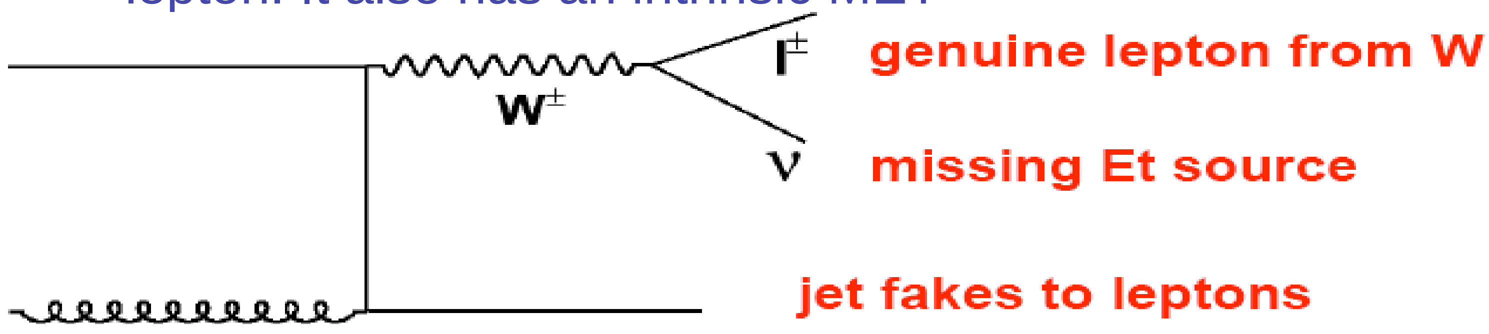
Common Analysis Strategies

- Instead of various groups (of a few people) doing in parallel same analysis from the beginning to the end, for example $H \rightarrow WW$:
  - Identify major analysis tasks (e.g., required for $H \rightarrow WW$)
  - Interested groups to contribute constructively to analysis tasks
  - Toward a common analysis (e.g., for $H \rightarrow WW$)
- Encourage different methods to extract background levels from the same process, directly from real data. This data-driven methods will help to have a cross-validation of the methods themselves, and will allow to estimate systematic effects for each of them. The analysis is a cut based analysis where cuts will be optimized when data will be available (using MC simulation also).
- Focus on better understood simple cut based analyses for early data
  - Acceptance challenge: converge on commonly agreed upon cut flow to common analysis. Example: https://twiki.cern.ch/twiki/bin/view/AtlasProtected/HiggsWW
- Common analysis tools in SVN repository

Background estimation from data

HSG3

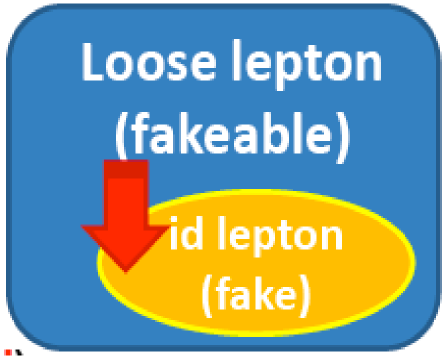
- Extraction of W+jets background in $H \rightarrow WW$ ($\rightarrow ll$+MET) +nj channel
  - W+jets background from one genuine lepton and one fake lepton. It also has an intrinsic MET



  - Hard to estimate jet -> fake lepton contribution for MC. W+jets cross section has large theoretical uncertainties
  - Use data driven background estimation methods, some examples:
    - Extrapolation method from loose leptons using di-jet events (fakeable objects)
    - Based on γ+jets events
    - Subtraction method
    - Estimate of opposite sign contribution from same sign
    - Estimation of $Z \rightarrow ll$ background in $H \rightarrow WW$ ($\rightarrow ll$+MET)+0j

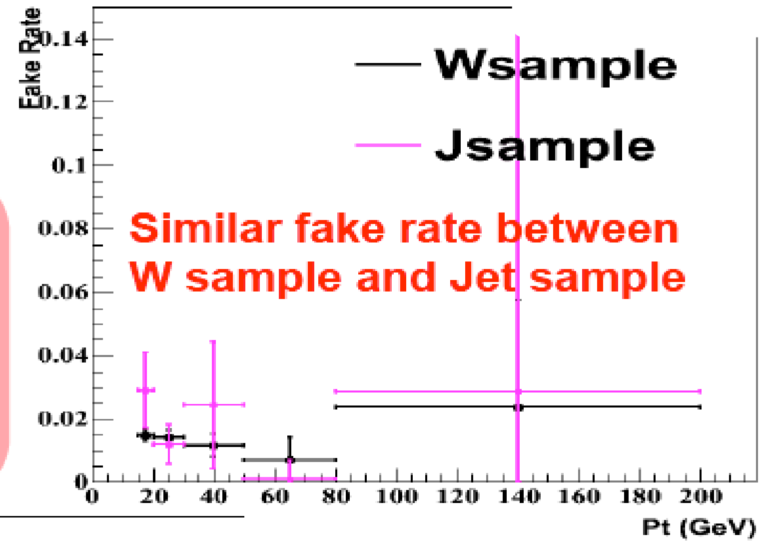
Background estimation from data: Fakeable objects

HSG3



Fake Rate Definiton

$$f_{lep} \equiv \frac{N_{\text{id obj}}}{N_{\text{fakeable obj}}}$$



How to apply

W+jets fake candidate

$$N_{\text{oneid(genuine)+onefake}} = f_{lep} \times N_{\text{oneid(genuine)+onefakable}}$$

Number of W+jets Fake background

Estimate from jet triggered data

Apply to signal data (lepton trigger sample)

For example

Good agreement with MC expectation

$$N^{\text{ee-ch}}_{\text{fake}} = f_e \times N_{\text{oneid e+onefakable e}}$$

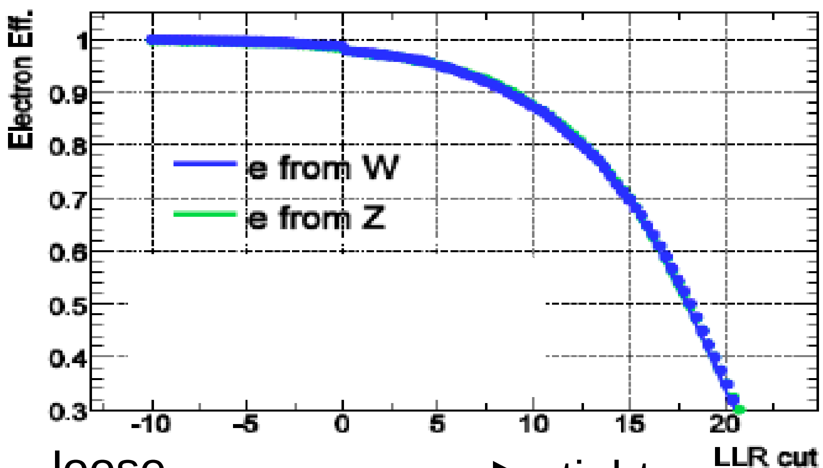
200pb^{-1}

Expected event after all selection	MC expectation (Counting)	LL method (f_e from di-jet)
ee-ch	3.4± 1.2	5.4±2.2

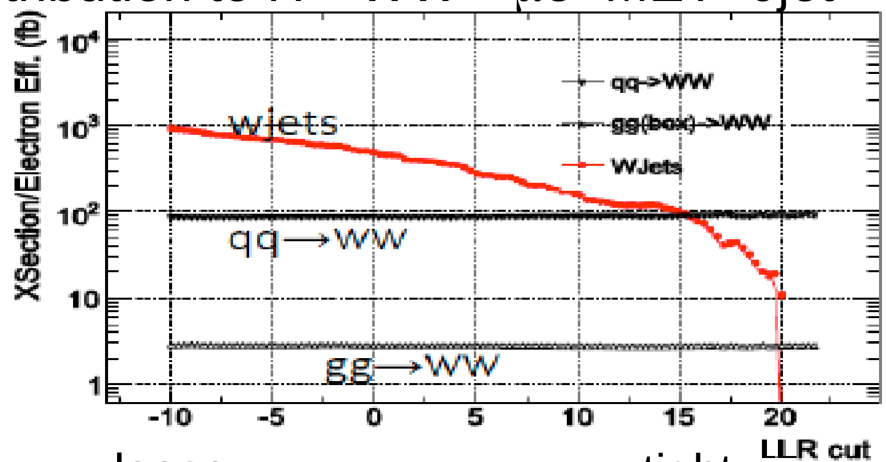
W+jets background estimation from data: subtraction method

HSG3

Estimate W(→μν)+jet (fake e) contribution to H→WW→μe+MET+0jet



loose → tight

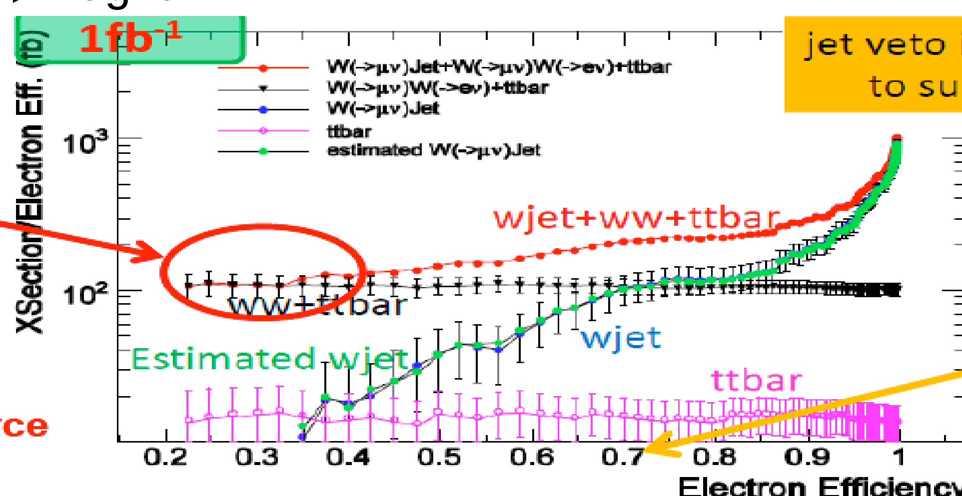


loose → tight

jet veto is implemented to suppress ttbar

In this region, we can determine constant value

Data statistics is dominant error source ~30-50% at 1fb^{-1}



working point

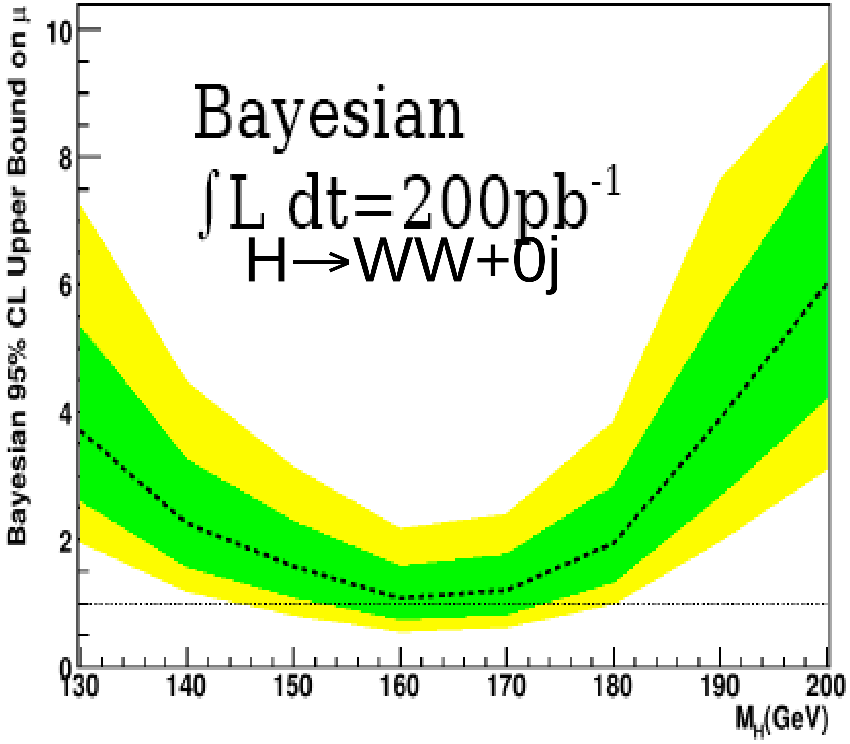
Tight electron id → Loose electron id

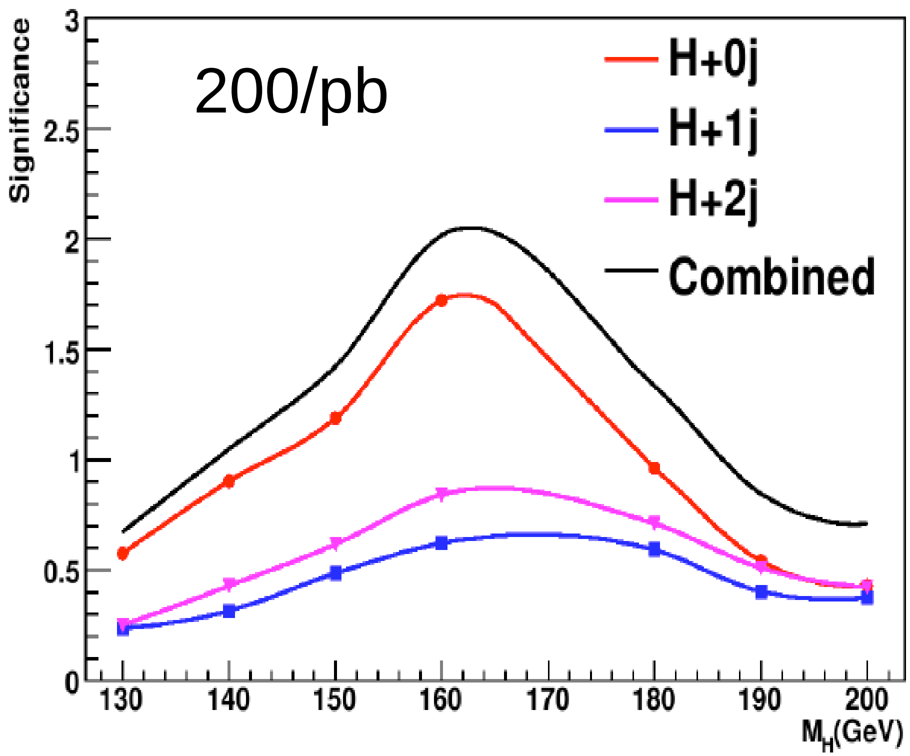
Estimated W+jet (green curve) consistent with W+jets from Truth (blue curve)

H→WW(→ll+MET) + njets:

HSG3

Aiming at producing a sensitivity plot with all the systematics before data taking starts; the group is working towards that goal.





- Exclusion: background systematics included from control samples but no systematic error on signal normalization.
- Discovery significance: still preliminary. Need some time to have systematics under control in all channels

This does take into account also ee and µµ, not only eµ sub-processes.

H→γγ in the early going …

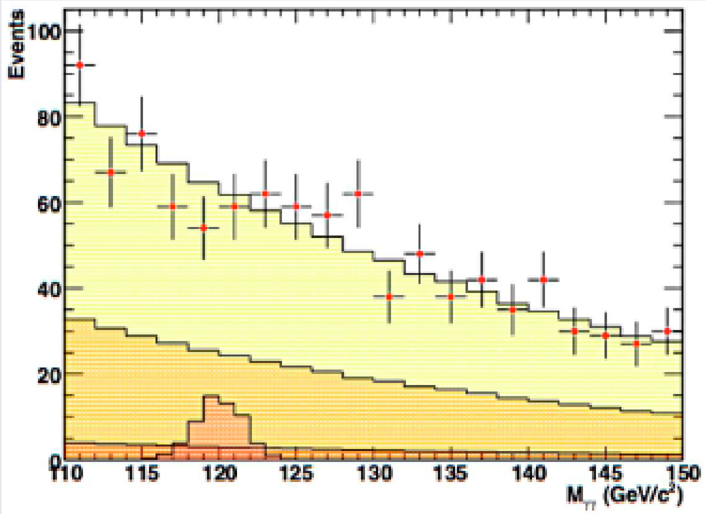
- Using inclusive analysis cuts $\begin{cases} |\eta| < 1.37, \quad 1.52 < |\eta| < 2.37 \\ p_T^1 > 40 \text{ GeV and } p_T^2 > 25 \text{ GeV} \end{cases}$

HSG1

Signal	120 GeV $\pm 1.4\sigma$
gg fusion	12.1 fb
VBF Higgs	1.5 fb
WH, ZH	0.8 fb
$t\bar{t}H$	0.1 fb
Total	14.5 fb

Background	120 GeV $\pm 1.4\sigma$
$\gamma\gamma$ irreducible	401 fb
γj reducible	209 fb
jj reducible	29 fb
Total	639 fb

With 200 pb^{-1} @ 10TeV



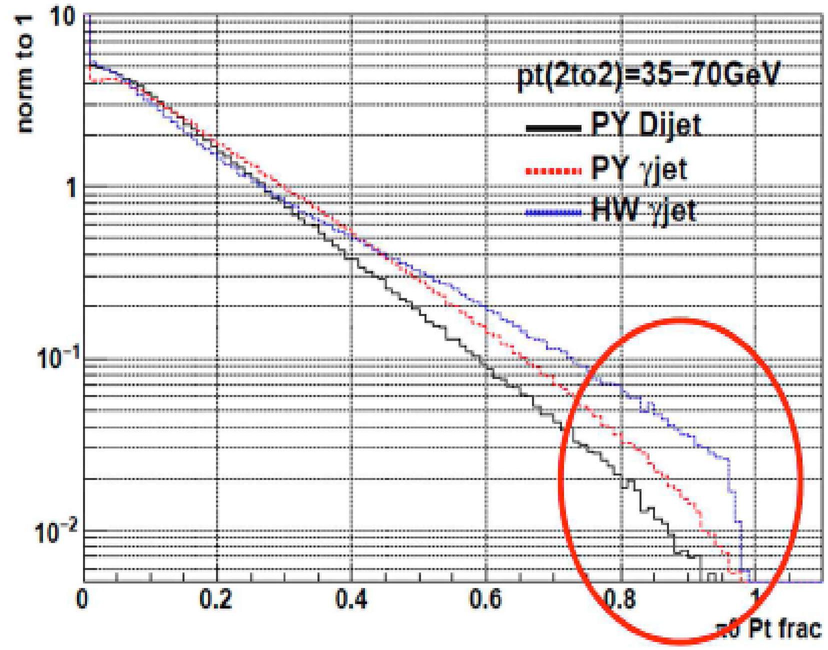
(Signal $\times 10$)

$\Rightarrow$ Only ≈ 3 signal events expected

≈ 128 background events

H→γγ in the early going …

- Good connection between Higgs sub-group HSG1 (γγ), direct photon sub-group and egamma performance group
  - Of interest to H→γγ:
    - Conversion
    - Calibration
    - Identification efficiency and purity
    - Software preparation
- Jet fragmentation to π^0
  - Differences in quark from di-jets and γ/jet observed
  - π^0 depends on generator used and on process considered



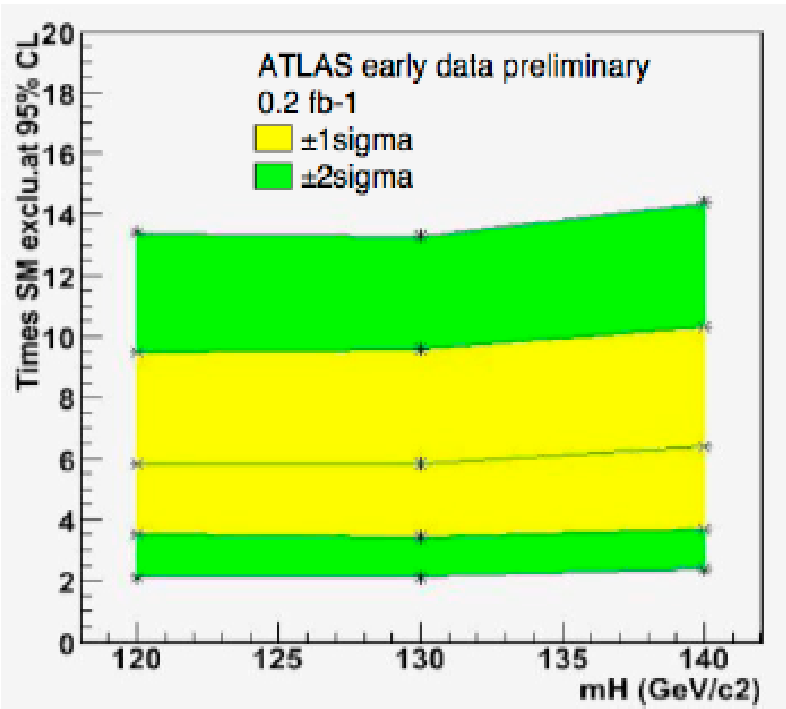
$$\pi^0 \text{ Pt frac} = \frac{p_T^{\text{truth } \pi^0}}{p_T^{\text{truth hard process quark}}}$$

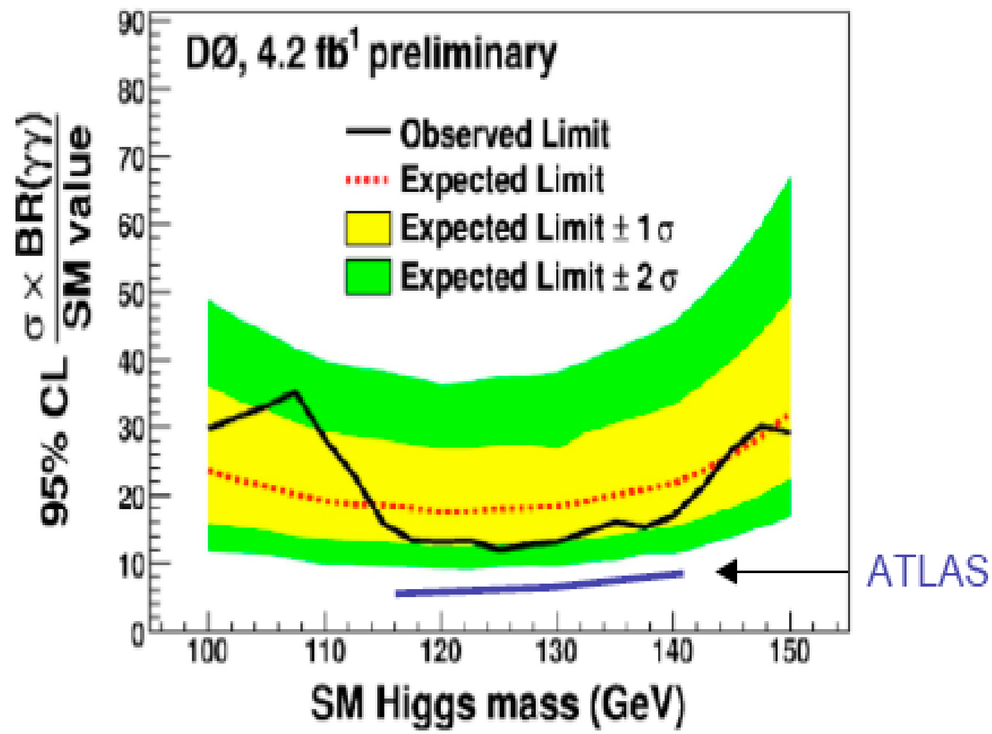
Which tuning to use?

How to constrain fragmentation function from data?

H→γγ in the early going …

HSG1



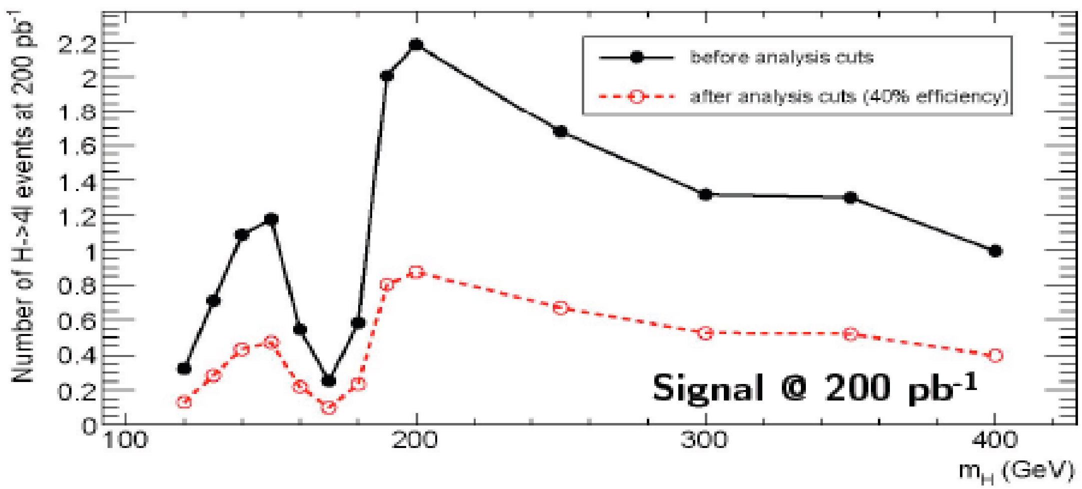


With 200/pb, we can exclude 6-8 times SM σ x BR (H→γγ)
Statistic and systematic errors to be further investigated

HSG2

H→ZZ(*)→4l with 200/pb

Process	$\sigma\times$BR (pb)	Events	4 leptons no p_T, η-cut	4 leptons with p_T, η-cut
Signal (200 GeV)	**10.9** $\cdot 10^{-3}$	**2.1**	**2.1**	**0.9**
ZZ	$\sim$16	3200	20	**3**
$t\bar{t}$ (1-l filter)	220	44000	650	**25**
$Z(\rightarrow ll)b\bar{b}$	40	8000	80	**7**
$Z \rightarrow ll$	$2 \cdot 1349$	$2 \cdot 270000$		$\sim$ **20**

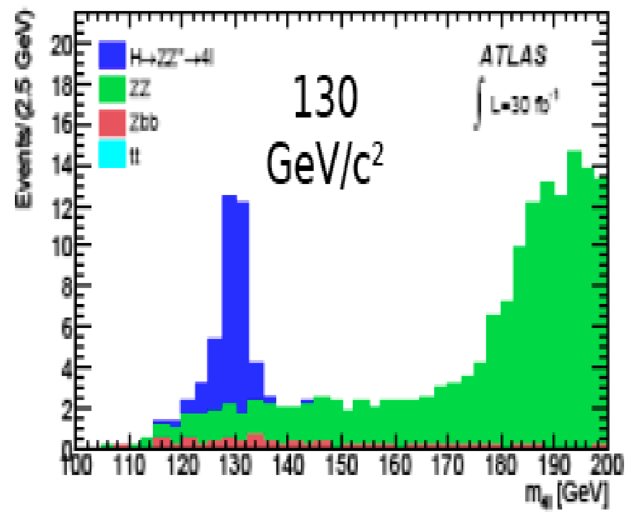


- Small number of events
- Loose cuts
- Work topics divided according <4l or ≥4l final states
- understand data comparing against known processes estimated with MC and data driven methods

$H \rightarrow ZZ^{(*)} \rightarrow 4l$ with 200/pb

HSG2

- $ZZ \rightarrow 4l$ background estimation from data
  - For 200/pb, number expected events small. Fitting side-band not possible
  - Use theoretical prediction for $\sigma(Z \rightarrow ll)$ with experimental acceptance. Subject to QCD scale, PDF and luminosity uncertainties
  - Much of the systematics go away if you normalize $ZZ \rightarrow 4l$ events to real data $Z \rightarrow ll$



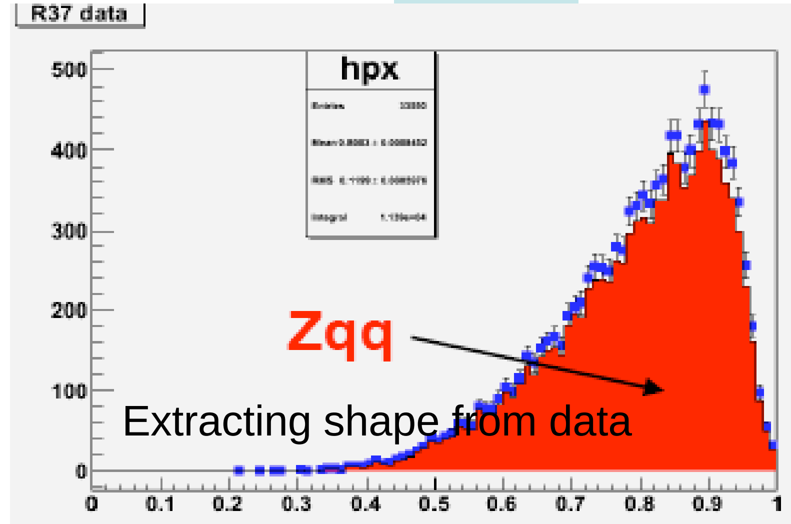
$$N_{estimated}(ZZ \rightarrow ll) = N_{measured}(Z \rightarrow ll) \cdot \sigma(ZZ \rightarrow ll)/\sigma(Z \rightarrow ll)$$

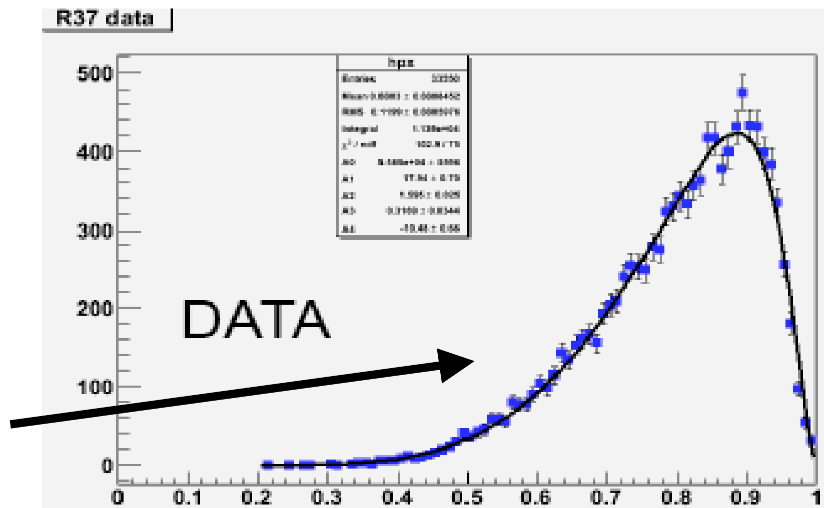
Progress on understanding theoretical systematics associated to the ratio. Need to address experimental issues associated to the ratio - in progress

Extraction of ZQQ (Z+jets)→4l background from data

HSG2

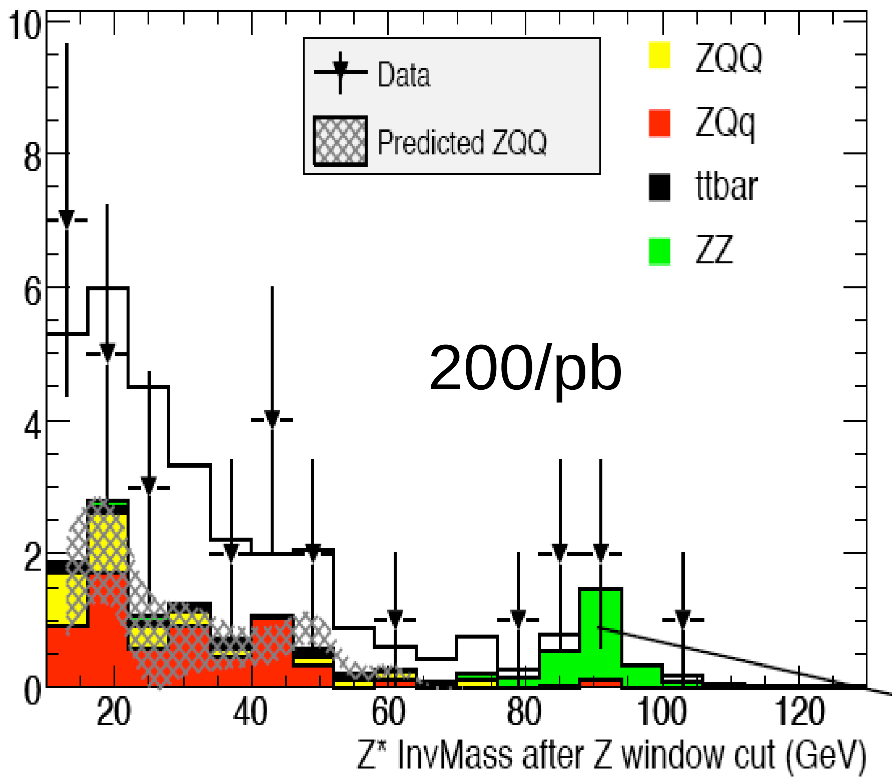
- $H \rightarrow ZZ(*) \rightarrow 4l$ have 3 types of backgrounds
  - Irreducible: ZZ(*)
  - Semi reducible: Z+X
  - Reducible: ttbar, W+jets, etc
- Zbb and Zcc dominate the Z+X contribution
  - At low m_H, could be 10-30% of ZZ*
  - But has large uncertainty. Needs to be extracted from data.
    - Measure Zqq in a statistically rich part of the phase space: make a Z→ee selection and plot qq→egmmas
    - Validate MC: Fix Zqq shape and normalization from data, by fitting R37 shower shape of the non-Z electrons. Extrapolate from egamma to loose electron using the MC to predict the Zqq contribution
    - Extrapolate into H→4l signal region

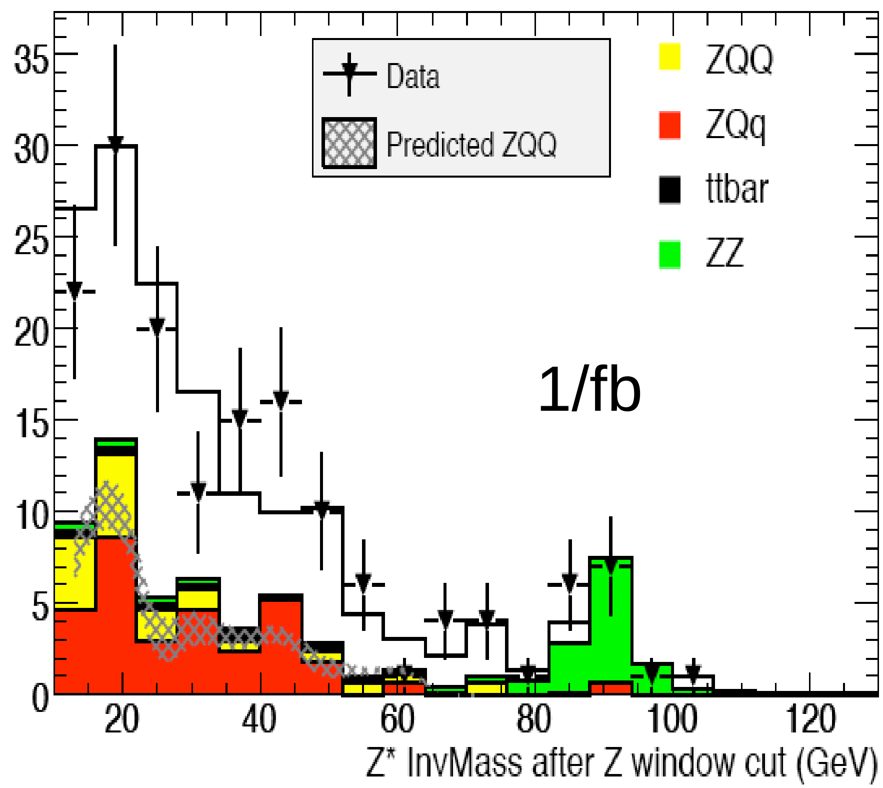




Extraction of ZQQ (Z+jets)→4l background from data

HSG2





Method over-predicts ZQQ, tends to include ZQq as well. ZZ measurement also possible. ZQQ and ZZ background extractions possible even at 200/pb, subject to larger statistical uncertainties.

Background estimation from data

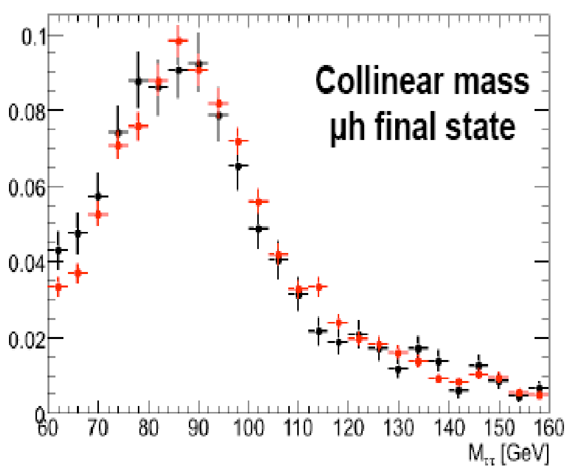
HSG4

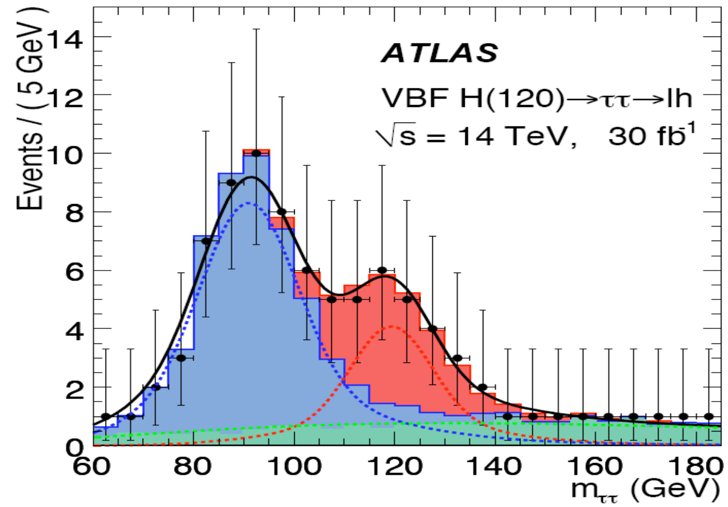
Examples: estimate $Z \rightarrow \tau\tau$ background from real data $Z \rightarrow \mu\mu$

Estimate W+jets backgrounds in lh channel using same sign leptons

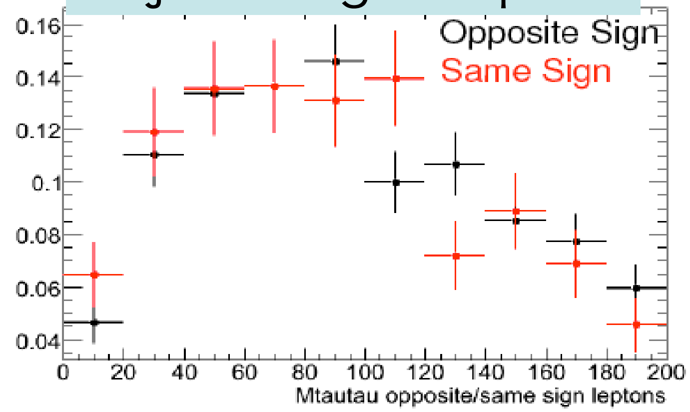
- $M_{\tau\tau}$ shape and rate affected by large systematics especially for Z with low p_t :
  - ($\tau\tau$ almost back-to-back, missing P_t balance may give large tails)
- Need to get $M_{\tau\tau}$ shape and rate from data, but it's difficult to select a pure $Z \rightarrow \tau\tau$ sample from data
- Build an "emulated" $Z \rightarrow \tau\tau$ sample:
  - Don't rely on simulation of Z production (cross-section, kinematic underlying event, etc), but **trust τ simulation**;
  - Select a pure sample of inclusive $Z \rightarrow \mu\mu$ events from data (easy!)
  - Replace reconstructed μ's with simulated τ's (same kinematics)

Good agreement between "true" and "emulated" $Z \rightarrow \tau\tau$





W+jets using SS leptons



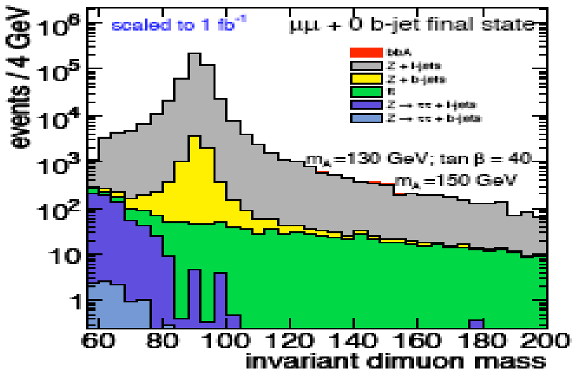
- The tools do this are now in the SVN repository
  - Being generalized for "remove/replace" background estimation from data
  - Not just for the Higgs WG. Useful to other groups as well

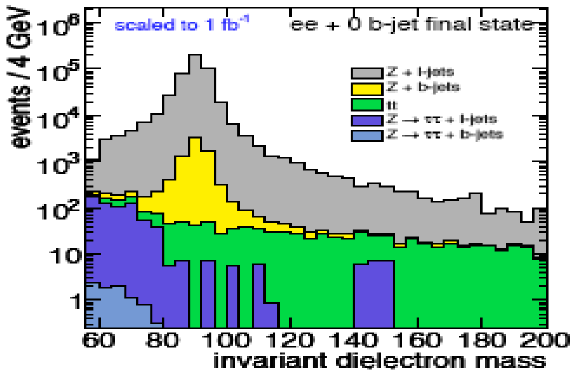
Background estimation from data

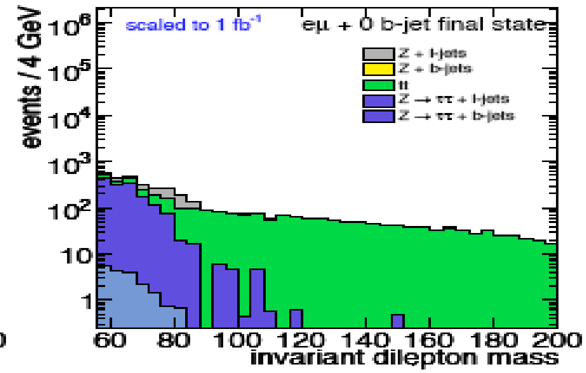
HSG4

- A→μμ: large backgrounds from Z+jets and tt. Shape extraction for the main backgrounds

0 b-jet channel







Background estimation with signal-free final states

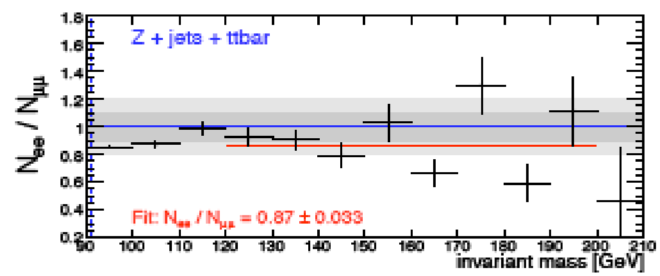
- $BR(A \to ee) \simeq 0$
- $BR(Z \to ee) = BR(Z \to \mu\mu)$
- $BR(t\bar{t} \to ee) = BR(t\bar{t} \to \mu\mu) = BR(t\bar{t} \to e\mu)$

⇒ **Strategy:**

1. Measure $\mu\mu$, ee and $e\mu$ final states
2. Estimate $\mu\mu$ background from ee final state (sum of Z+jets and $t\bar{t}$ contribution)
3. Additionally: $t\bar{t}$ contribution from $e\mu$

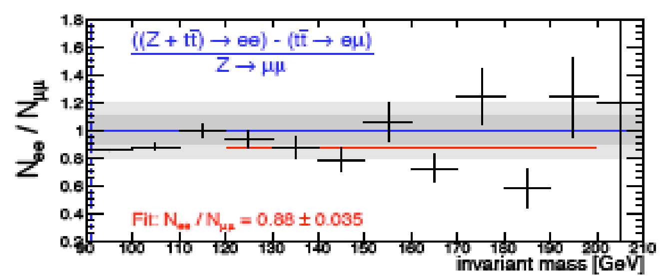
With 200/pb:
Normalization estimation: ~20%
Shape extraction: ~4%

ee control sample



200/pb

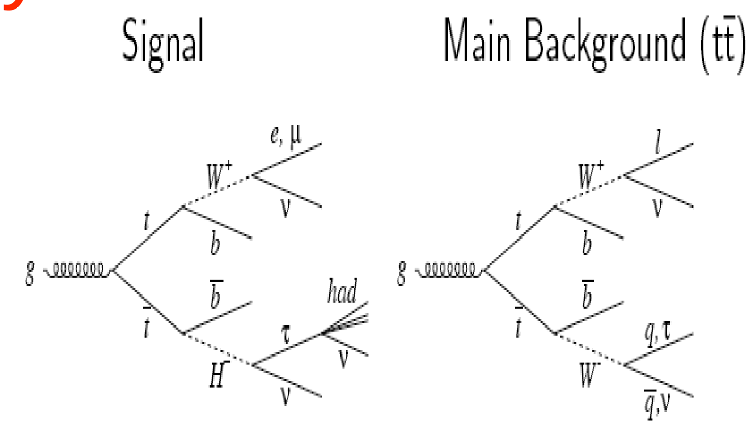
Z_{only} estimate from ee and $e\mu$ samples



HSG5

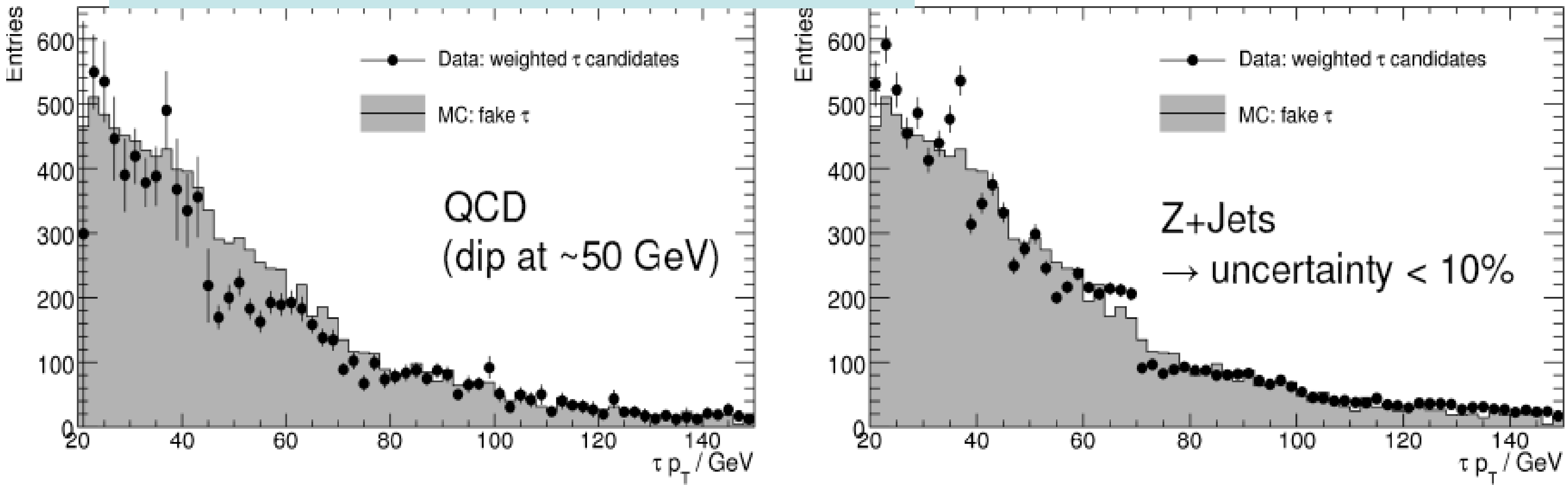
$H^+ \to \tau\nu$ in early data

- Estimation of fake τ from light jets in ttbar (semileptonic) background to $H^+ \to \tau\nu$
  - Fake τ major contributor to tt background. Needs to be well understood
  - Use "clean" QCD di-jet and $Z \to ll$+jets data to measure the fake-τ rate
  - Estimate τ-weight using fake rate and τ-ID efficiency



composition of $t\bar{t}$ background	
real τ-jets	44%
fake τ-jets from electrons	28%
fake τ-jets from light jets	26%

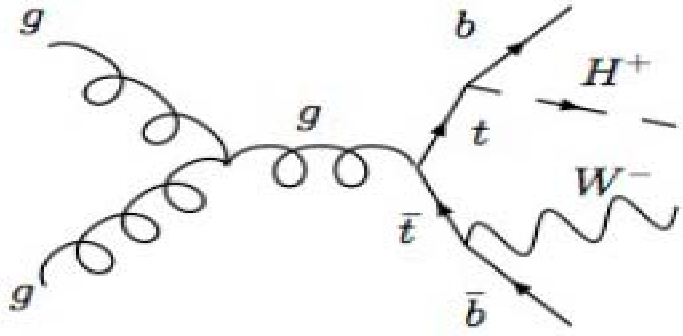
p_T spectrum of fake τ in ttbar events. Using rejection measured in data



In progress. Systematics to be understood

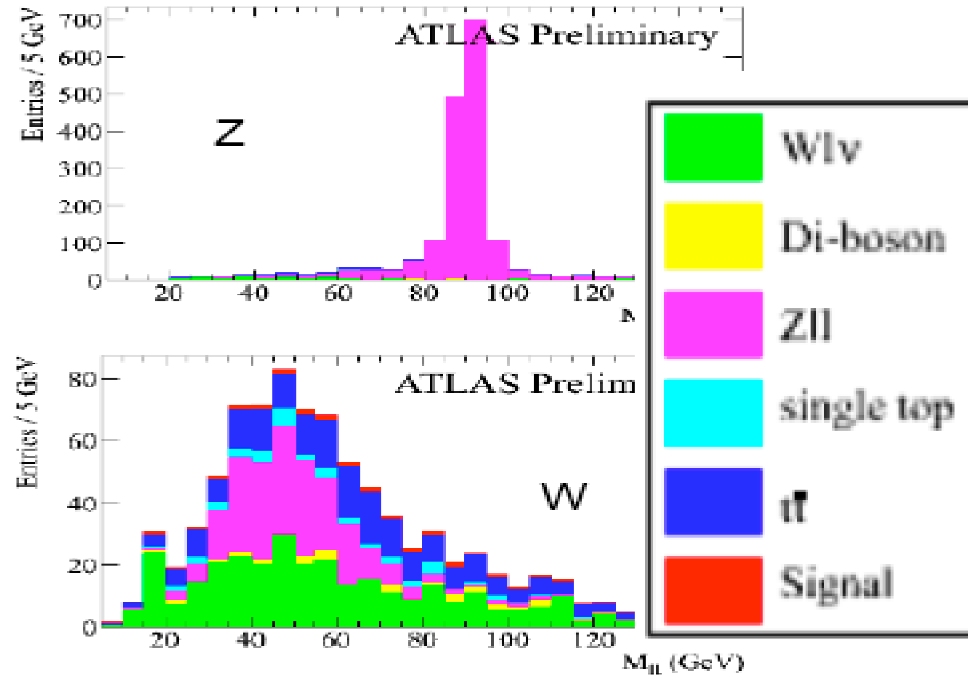
HSG5

$H^+ \rightarrow \tau\nu \rightarrow l\nu\nu\nu$ in early data

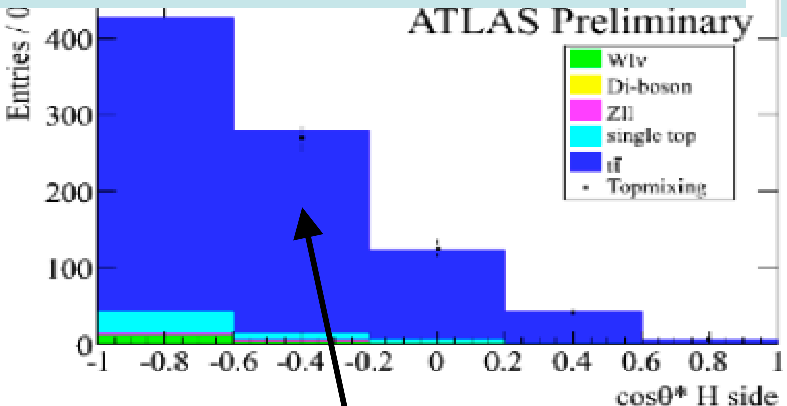


Both the W and the H decay fully leptonically ($H \rightarrow \tau\upsilon \rightarrow l\nu\nu\nu$),

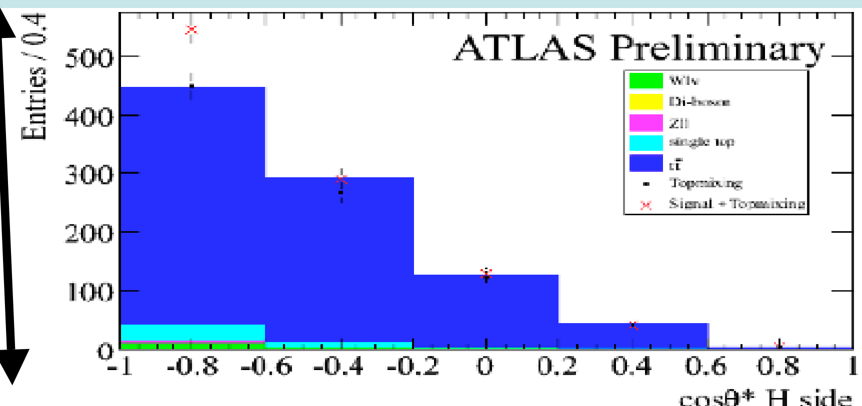
Disentangling the backgrounds by normalization of MC to data in the W and Z side bands



Look at top mixed sample



Add signal to top mixed sample and repeat - assume BR($t \rightarrow bH^+$) upper limit from Tevatron



Data consistent with SM within 1σ

4.6 σ excess over SM expectation

Other Higgs WG activities not presented today

- Trigger studies for start up menus
- Update of Higgs cross sections and branching ratios for:
  - LHC energies in the early going
  - Up-to-date theoretical estimates
- Learning how to use the tools and contributing to the development these tools:
  - TAG based event skimming for Higgs D2PD and D3PD
  - Luminosity estimation for Higgs data samples
  - Usage of data quality flags in Higgs analyses
- Higgs D2PD and D3PD content definitions

Conclusions

- A lot of activities in the Higgs WG towards early data
- Data-driven background estimation methods being developed. In some cases methods useful to other groups (performance and SM)
- Efforts in various Higgs sub-groups towards common analysis strategies
- With 200/pb, expect:
  - 95% CL exclusion limit in $H \rightarrow WW$ (m_H ~ 160 GeV)
  - N x σ(SM) exclusion at 95% CL in other channels

Backup

$H \to \gamma\gamma$ exclusion limit in early data

1- Simulate experiments (toyMC) with only background (B toys) and signal+background (S+B toys),

with m($\gamma\gamma$) follow the CSC parameterization:
- a *crystalball for the signal*, with mass resolution σ
- an *exponential for the background* .

2- Fit each toyMC with the number of signal Ns float and Ns fix to a certain hypothesis (ex. Standard Model $H \to \gamma\gamma$ cross section)

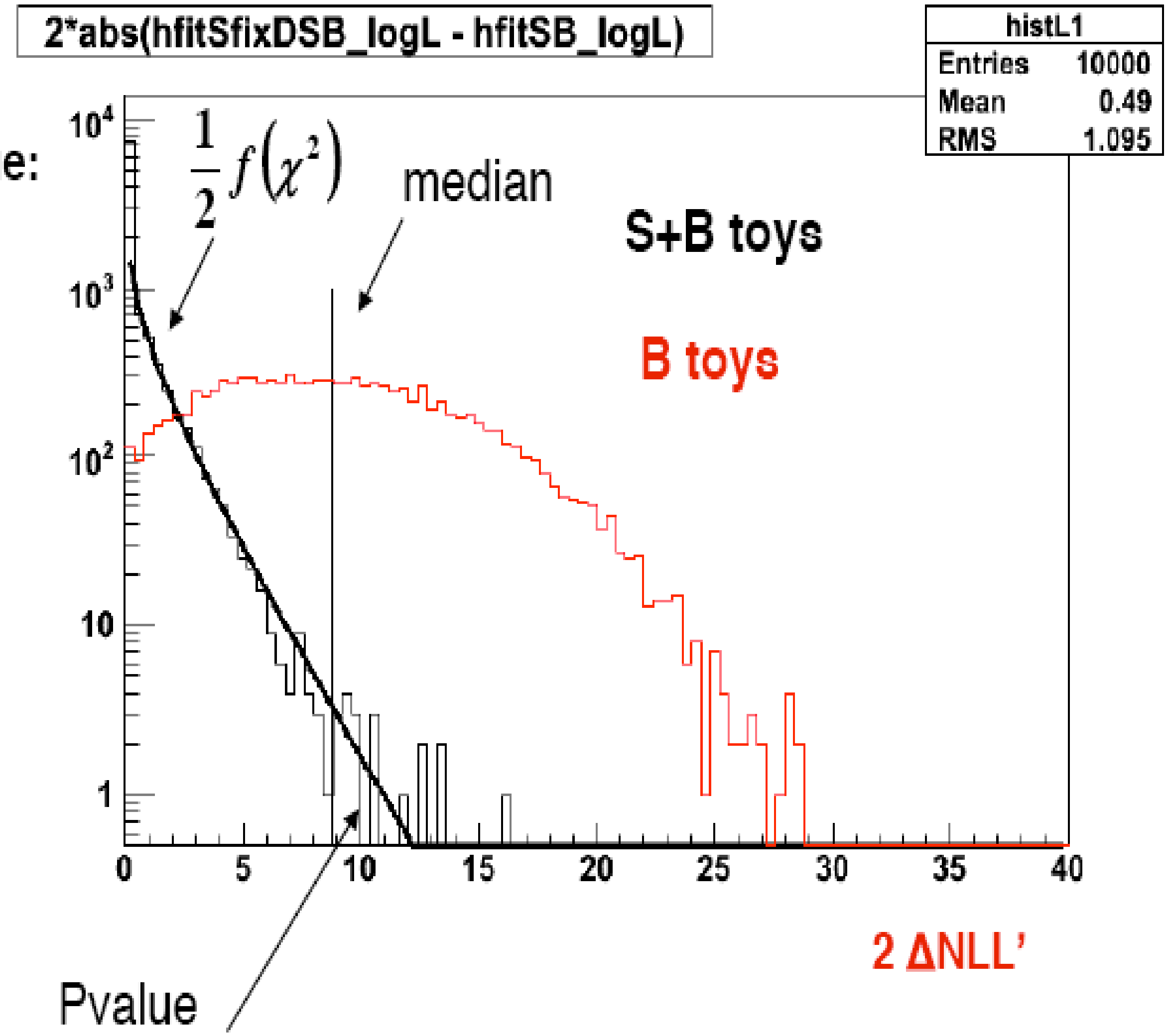
3- Evaluate:

$$\Delta NLL = \begin{cases} \ln L\left(fit\left(NS \geq 0, NB\right)\right) - \ln L\left(fit\left(NB\right), NS_{fix}\right) & \text{If NS} \leq \text{NSfix} \\ 0 & \text{If NS} > \text{NSfix} \end{cases}$$

H→γγ exclusion limit in early data

4- The CL is related to the **Pvalue:**

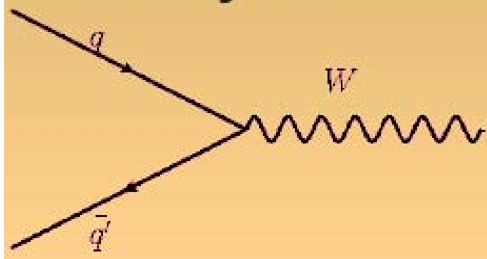
$$CL = 1 - (Pvalue)$$

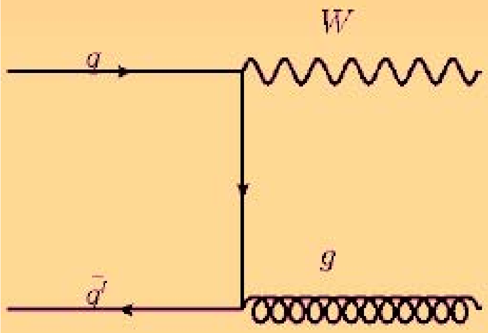


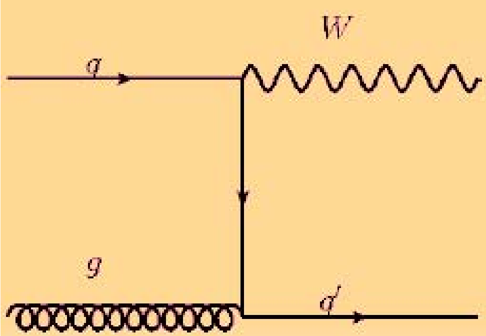
Pvalue is the fraction of S+B toys having a DNLL' value higher than the median

γ+jets is the closest thing to W+jets

- W + jets

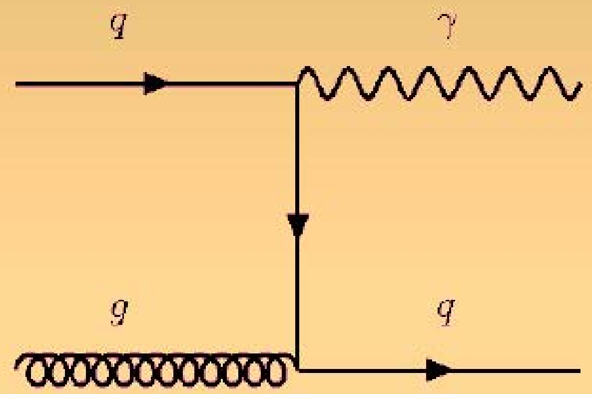


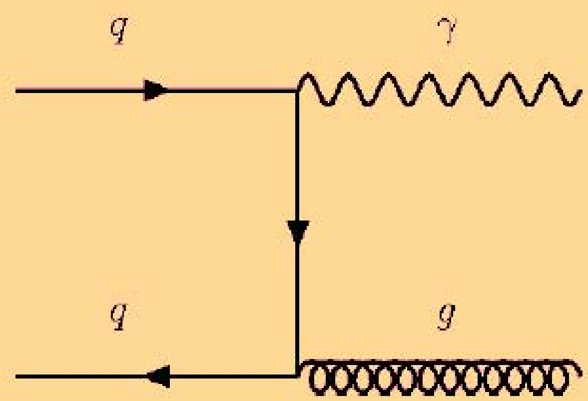




- Cross section (leptonic)
  - Total: 20.5nb
- Z→μμ
  - Total: 2.02nb
- Photon + jets (p_T>20GeV)
  - Total: 180nb

- Photon + jets





Spring 2010 with a few pb^{-1}

- **Mainly calibrations and understanding of the detector performance: Collaborations with Trigger and CP Groups will be important**
  - Tight connections with Trigger/TDAQ Groups – understand trigger performance (mainly LVL1);
  - Contribute to the understanding of lepton reconstruction: validation, robustness, first fake and efficiency studies from data of leptons and photons.
  - Contribute to calibration and alignment tasks.
  - Involvement in Jet, MET and b-tagging performance
  - Use control samples for detector performance (from performance groups)
- **First physics analyses (ATLAS wide…):**
  - Minimum bias
  - Lepton spectrum
  - Jet spectrum
  - …

Summer 2010 with a few tens of pb^{-1}

- **Expect somewhat improved detector/trigger performance**
  - Maintain connection with performance groups as stated in the previous page
  - In addition: Lepton trigger and reconstruction performance, using tag and probe methods. Lepton/photon isolation and impact parameter understanding
  - Understanding of fake and secondary lepton sources. Better understanding of Jet, MET, b-tagging and photon ID performance
  - Involvement in calibration, alignment, data quality and luminosity estimation
- **Data-Driven Background Estimation**
  - Tight connection with SM and top groups
  - Simple cut-based analyses
  - Control samples for our background estimation from data - minimal reliance on MC
  - Optimized cut-analysis for exclusion limit settings
  - Background cross-section measurements.

Trigger efficiency studies for semileptonic ttH ($H \rightarrow bb$)

UCL

	e15_medium	e20_loose	e20i_loose	e25i_loose	mu15	mu20	mu20i_loose
L1	100%	99.9%	89.4%	88.3%	88.3%	87.0%	87.0%
L2	96.3%	95.1%	86.8%	85.4%	84.4%	81.7%	62.3%
EF	84.2%	92.9%	85.6%	84.2%	83.0%	80.6%	61.5%

(10 TeV, 10^{31} trigger menu)

Lepton trigger efficiencies vary between 85-90%, except muon trigger at L2, due to isolation criteria

e20i_loose || mu20 || bjet	79.3%
e20i_loose || mu20 || bjet || xe40	86.4%
e20i_loose || mu20 || 3j180 || xe40	86.1%
e20i_loose || mu20 || 4j95 || xe40	86.4%

Jet, b and MET triggers have low efficiencies, but can contribute in combination with lepton triggers

Efficiencies from signal samples at 10 TeV, 10^{31}-trigger menu and 14 TeV, 10^{34}-trigger menu maintain similar efficiencies

	10 TeV $10^{31}cm^{-2}s^{-1}$	14 TeV $10^{34}cm^{-2}s^{-1}$
electron trigger	85.6%	84%
muon trigger	80.6%	79%
combined lepton trigger	83.0%	82%

Early Analysis Planning

- With 2/pb batch
  - Jets (di-jet, multi-jets)
  - Minimum bias
  - J/ψ, Υ
  - Inclusive electrons/muons to W, Z, first MET
- With 20/pb batch
  - Measurements with photons
  - Top measurement
  - Tau ID
  - W and Z distributions and properties
  - …

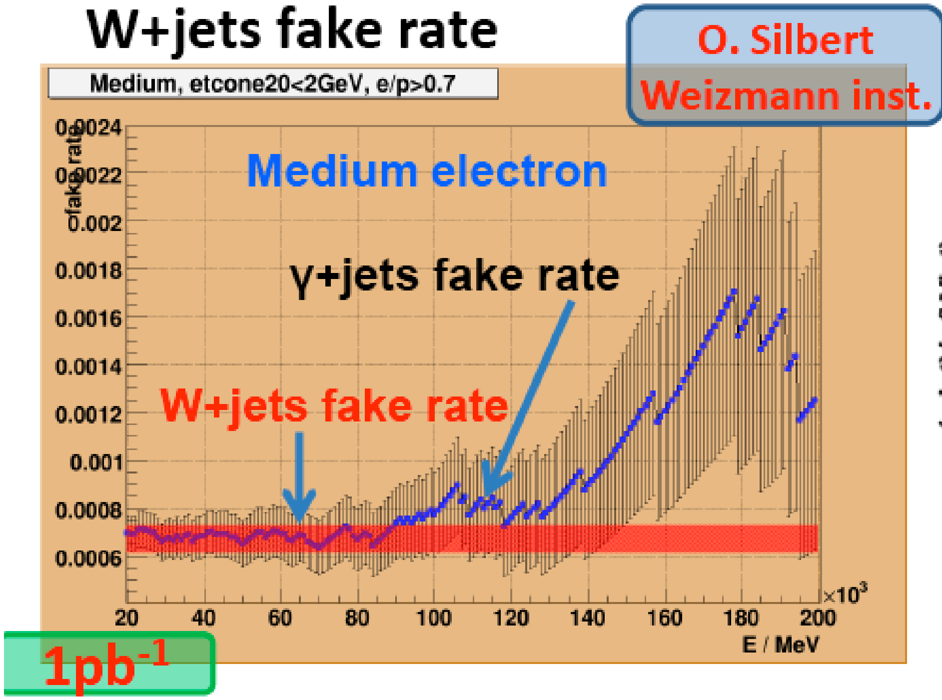
$Z \rightarrow ll$ background estimation in $H \rightarrow WW+0j$

- $H \rightarrow WW \rightarrow ll+\nu\nu$ requires good understanding of MET, among other things
- $Z/\gamma \rightarrow ll$ could be a major background if detector effects and mis-measurements lead to significant fake MET
  - Need to understand MET in the signal region, $15 < M_{ll} < 70$ GeV
  - Assuming good reconstruction of leptons in Z-peak region, MET from detector effects could be understood
    - Extract parameterization of MET in the Z-peak region to predict events in the signal region
    - Independent, data-driven background estimation of $Z/\gamma \rightarrow ll$ in $H \rightarrow WW$ ($\rightarrow ll$+MET)+ 0j

In progress. Liu et al

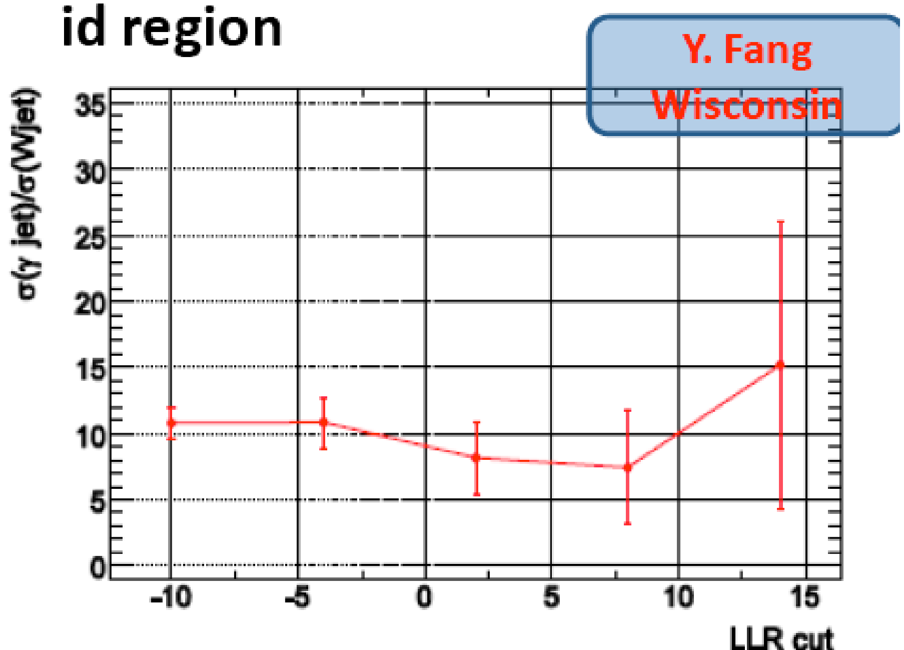
W+jets background estimation for data: using γ+jets events

- γ+jets fake rate is very similar to W+jets fake rate



- It's important to check the impact of the trigger on this method
  ➔ Under studying

- Cross section ratio seems to be flat ➔ might be possible to extrapolate from loose electron id region



Loose electron id → Tight electron id

$$\sigma(\mathrm{Wjet})_{\mathrm{tight}} = \frac{\sigma(\gamma\mathrm{jet})_{\mathrm{tight}}}{\sigma(\gamma\mathrm{jet})_{\mathrm{loose}}}\,\sigma(\mathrm{Wjet})_{\mathrm{loose}}$$

Acceptance Challenge

- Example of H→WW (→ll+MET)+0j, 1j or 2j
  - Various groups involved in H->WW+0j analysis
  - Converge on common cut based selections - for details see https://twiki.cern.ch/twiki/bin/view/AtlasProtected/HiggsWW
    - Trigger selection - single lepton (e, m) trigger
    - Offline pre-selection: at one least lepton of p_T>10 GeV. Use lepton definitions of egamma and muon performance groups.
    - Higgs candidate pre-selection cuts. Designed to suppress backgrounds: ZW, bbar, Z, Z*
    - Final Higgs selection cuts: defines the signal box; include topological cuts, suppression addition backgrounds, e.g., ttbar:
      - Separately for 0j, 1j and 2j analysis
  - Various groups to run the analysis
    - Cut efficiencies/rejections should be consistent
  - Discuss our cut flow with SM group
    - Converge on common object selections with SM group

final analysis optimization will be done when real data will be available.

W+jets background estimation from data: using same sign events

H. Liu
Michigan

- Expected to be ε' > ε due to charge correlation

Medium Electron

N_{jet}	$\sigma^{\text{signal}}_{e^+e^-}$ (fb)	$\sigma^{\text{signal}}_{e^\pm e^\pm}$ (fb)	$(\epsilon'/\epsilon)^{\text{signal}}$
0	683.13	226.20	3.02 ± 0.58
1	273.66	134.19	2.04 ± 0.60
2	109.89	57.32	1.92 ± 0.49
3	41.47	26.69	1.74 ± 0.35

Loose Electron

N_{jet}	$(\epsilon'/\epsilon)^{\text{signal}}$
0	1.13 ± 0.32
1	1.25 ± 0.34
2	1.28 ± 0.53
3	0.84 ± 0.48

- ε'/ε decreases as jet multiplicity increases due to less charge correlation (more gluon jets)
- ε'/ε decreases as electron quality decreases

➔ **Measurement of ε'/ε from control sample (real data) is key of this method (ongoing)**

$H \rightarrow ZZ(*) \rightarrow 4l$ with 200/pb

- Final states with <4l (working with performance and SM groups
  - $Z \rightarrow ll$ inclusive, $Z \rightarrow ll$+n jets, ttbar, WZ, ZZ
  - Lepton trigger and reconstruction efficiency
    - Tag and probe with $Z \rightarrow ll$ and $J/\psi \rightarrow ll$
  - Fake and secondary leptons
    - $Z \rightarrow ll$: inclusive or + n jets
    - QCD di-jets
  - Charge distribution in multi-lepton final states
    - Relevant for lepton pairing

$H \rightarrow ZZ(*) \rightarrow 4l$ with 200/pb

- Final states ≥ 4l, background studies in the Higgs WG
  - Rely on the studies of <4l
    - e.g., 3l+good track or 3l+good cluster
    - Optimization of lepton isolation and IP cuts (no pileup or pileup)
  - Z-background measurement from data
    - Control sample studies on MC, preparing for data-driven extrapolation methods into signal region
  - ZZ-background
    - By normalization to real data $Z \rightarrow ll$ events (in progress)
    - Disentangling ttbar, Zbbar, ZZ background contributions

DQ Flags in Higgs Analysis

Exercise for putting DQ information

Nikolopoulos
Tsuno

Stick around "top-mixed sample" (run#108173) for testing.

Artificially creates bad DQ.

* Consider RUN 108173 (22594 LBs) (one LB = 1min.)
* Flag approx. 10% of the LBs with some DQ Flags BAD
* For simplicity use the first 10%
* Only consider RED (bad) or GREEN (good)
* All DQ Flags in COOL folder should be marked GOOD besides the ones below
* COOL FOLDER OFLP200 database (tag name: "**DetStatusLBSumm-TopMix1**")

Uploading the DQ … (put DQ as BAD)

~% cat file_0 : 108173 1 225

LB range

```
detStatus_upload.py --r 108173 --flag RED "sqlite://;schema=mycool.db;dbname=OFLP200" file_0 DetStatusLBSumm-TopMix1 EMBA EMBC
```

run number

detector flag

COOL DB

DB tag name

detector element
(EM barrel A-side : RED)

Checking the DB … (will have long list.)

```
detStatus_query.py --r 108173 "sqlite://;schema=mycool.db;dbname=OFLP200" DetStatusLBSumm-TopMix1 ALL
```

Ask authorized people to propagate into "Oracle DB" … (ask Richard.)

DQ Flags in Higgs Analysis

Case studies

Demonstration:

1) Z -> ll cross section measurement
2) Acceptance for H->WW
3) Acceptance for H->4 leptons

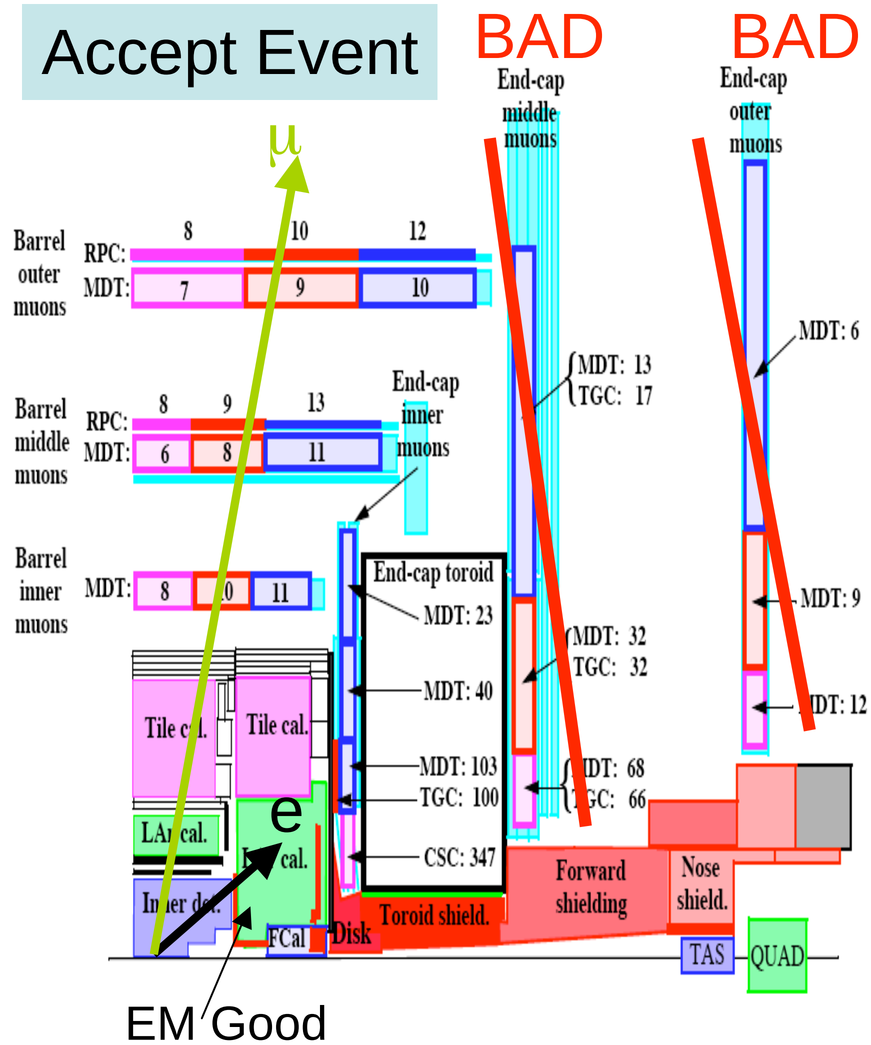
For simplicity, we only consider as DQ:

1) **EM barrel (EMBA+EMBC)**
   -- barrel-electron (| η | < 1.475)

2) **EM endcap (EMEA+EMEC)**
   -- endcap-electron (1.375 < | η | < 3.2)

3) **MDT/RPC barrel (MDTB+RPCB)**
   -- barrel-muon (| η | < 1)

4) **MDT/TGC endcap (MDTE+TGCE+CSCE**
   -- endcap-muon (1 < | η | < 2.7)



DQ Flags in Higgs Analysis

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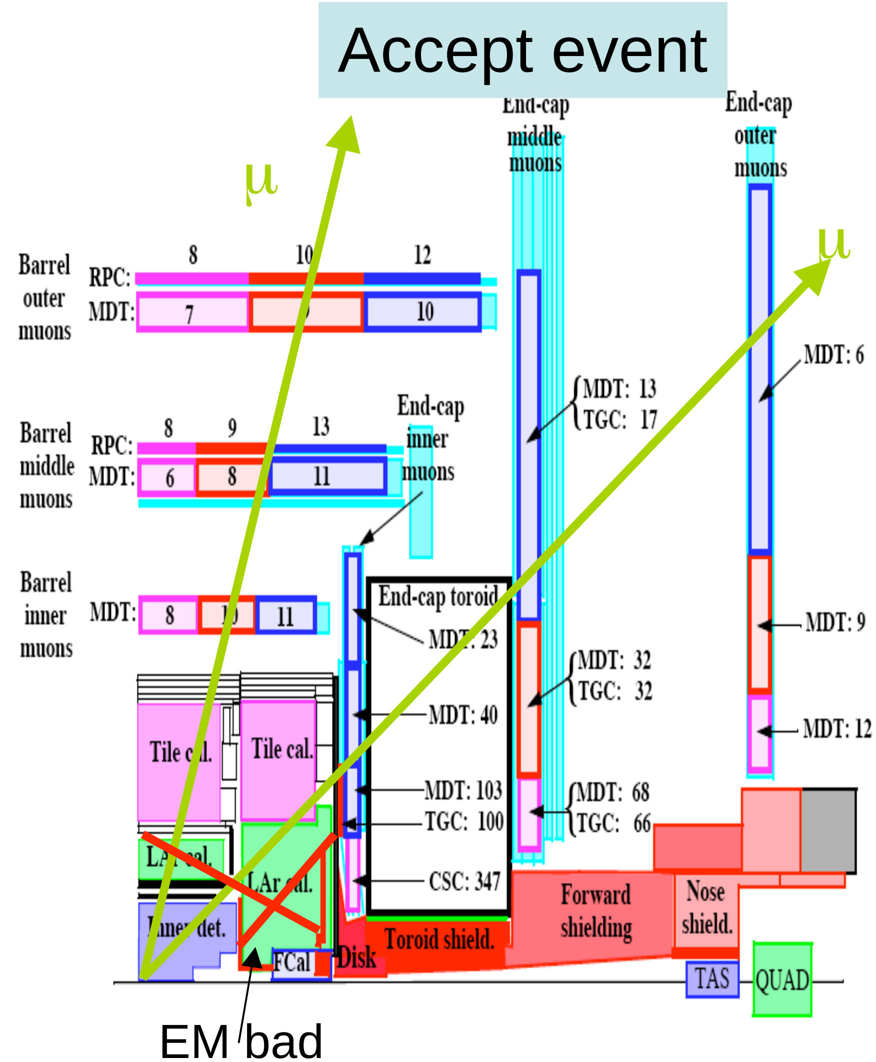

DQ Flags in Higgs Analysis

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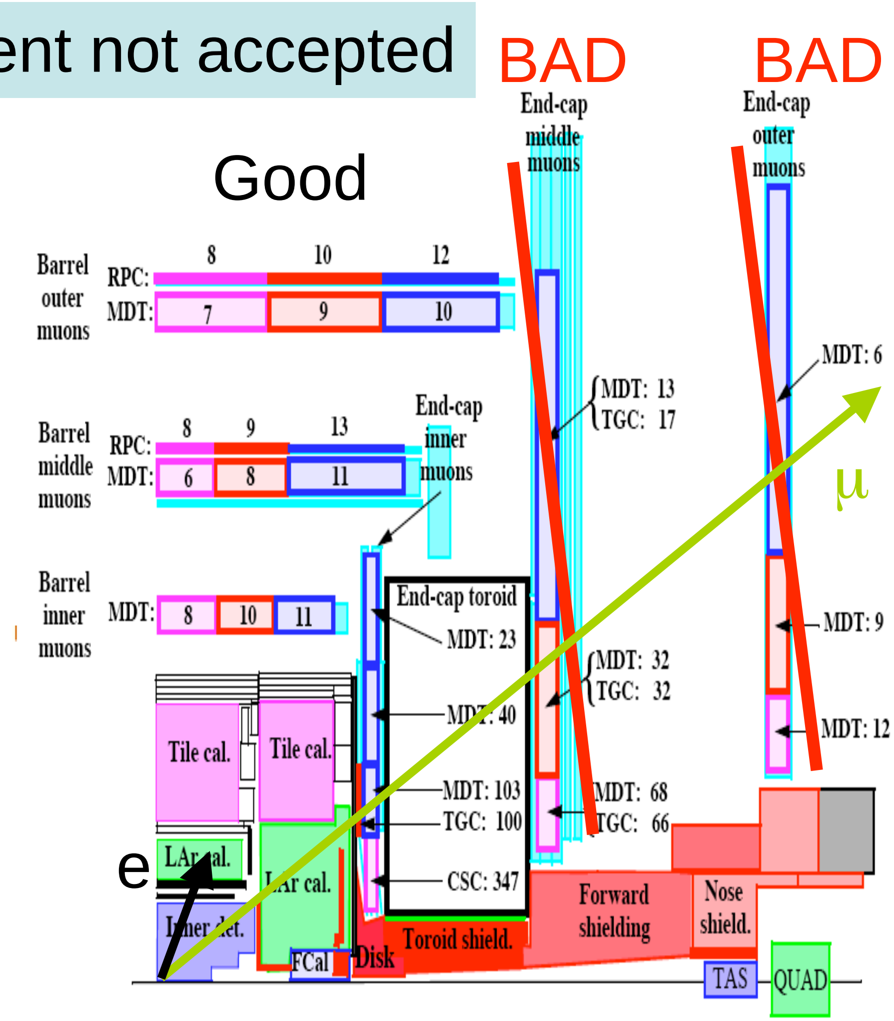


DQ Flags in Higgs Analysis

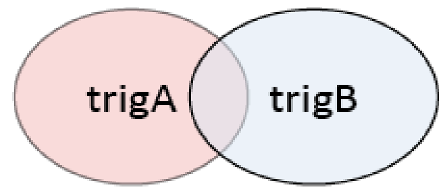
Case study (2)

H -> WW channel

provided by trigger group

by performance group

$$\text{Acceptance} = Acc_{\text{MC}} \times \varepsilon_{\text{trig}} \times \varepsilon_{\text{ID}} \times \cdots$$



A: single electron

B: single muon

$$\varepsilon_{\text{trig}} = \varepsilon_{\text{trigA}} + \varepsilon_{\text{trigB}} - \varepsilon_{\text{trigA}} \cdot \varepsilon_{\text{trigB}}$$

Using DQ information, different luminosity is obtained for different regions.

Accordingly, we have to calculate acceptance separately based on the geometrical configuration.

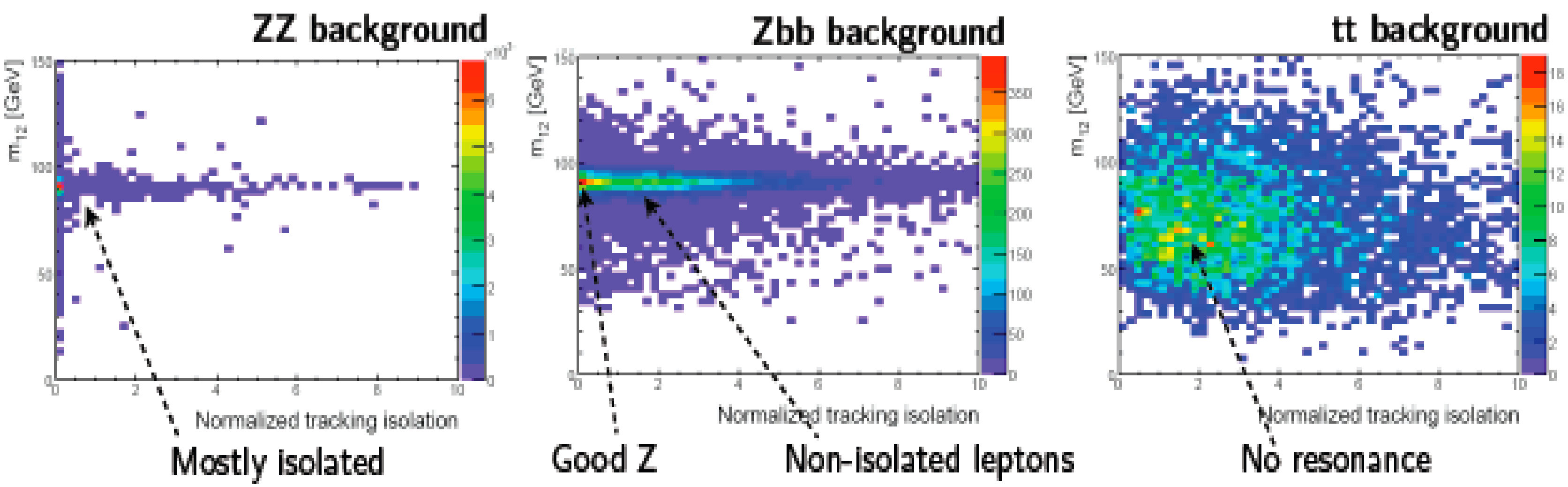
Tatsuya Masubuchi

	Acc.(%) (frac.)	LiveTime(sec)	IntL (nb^{-1})	Events	Good LBs	Bad LBs
no DQ flag	13.1 (100.)	1355160.0450	134782.14	1262005	22586	0
$2e$						
EMB-EMB	1.69 (12.9)	1313280.0436	130618.11	1223016	21888	698
EMB-EME	0.404 (3.08)	1286280.0427	127930.17	1197848	21438	1148
EME-EME	0.138 (1.06)	1299780.0432	129275.42	1210444	21663	923
2μ						
MDTB-MDTB	1.6 (12.2)	1299720.0432	129269.76	1210391	21662	924
MDTB-MDTE	1.28 (9.75)	1286220.0427	127923.65	1197787	21437	1149
MDTE-MDTE	1.22 (9.33)	1313280.0436	130617.26	1223008	21888	698
$e\mu$						
EMB-MDTB	3.64 (27.8)	1286220.0427	127924.51	1197795	21437	1149
EMB-MDTE	1.84 (14.0)	1299780.0432	129272.00	1210412	21663	923
EME-MDTB	0.218 (1.67)	1272720.0423	126581.82	1185223	21212	1374
EME-MDTE	1.06 (8.1)	1286280.0427	127929.32	1197840	21438	1148

$H \rightarrow ZZ(*) \rightarrow 4l$ with 200/pb

HSG2

- For m_H < 200 GeV, additional backgrounds from ttbar and Zbb:
  - To be studied by relaxing cuts on lepton isolation and impact parameter
  - Use 2D distributions (m_{12} versus isolation)
  - Shape of (m_{12} versus isolation) distributions for ttbar, Zbb and ZZ taken from MC
  - Fit these shapes to data and extract the relative contributions



Method under study: for 200/pb statistics and systematic effects on the background shapes

W+jets background estimation from data: using same sign events

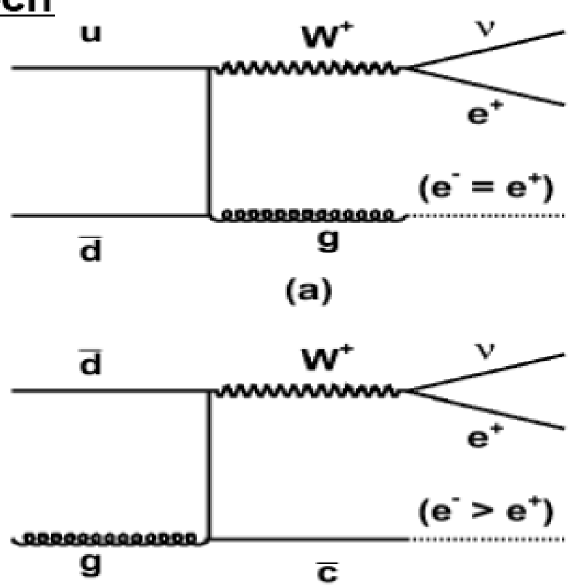
HSG3

- **The idea is that predict W+jets contribution in the opposite sign (N_{l+l-}) signal region from same sign (N_{l+l+} , N_{l-l-})region**

$$N^{\mathrm{data}}_{\ell+\ell-} = (N_{\ell+\ell+} + N_{\ell-\ell-})^{\mathrm{data}} \times (\epsilon'/\epsilon)$$

Opposite sign fake rate $\epsilon' \equiv \frac{N_{\ell+\ell-}}{N_{\ell^+} + N_{\ell^-}}$ Same sign fake rate $\epsilon \equiv \frac{N_{\ell+\ell+} + N_{\ell-\ell-}}{N_{\ell^+} + N_{\ell^-}}$

ee-ch



Gluon jet is likely to fake to e^+ or e^- in same probability
➔ ε and ε' should be same

Quark jet has charge correlation with W
➔ The quark tends to have opposite charge of W charge, it is more likely to fake to opposite charge event

➔ **Measurement of ε'/ε from control sample (real data) is key of this method (ongoing)**